

Water-related energy savings

– a guide for owners and managers of sports and leisure centres



- Explains water-related energy use in leisure centres
- Details savings available from energy efficiency measures

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1 INTRODUCTION

In a typical sports or leisure centre, energy costs are second only to labour costs, and a large proportion of the energy costs (up to 70% in centres with a pool) is associated with water.

Pool water is an expensive commodity; not only must the cost of the energy for heating the water be taken into account, but so must the cost of supply, disposal (effluent) and chemical treatment. A manager who is well informed on water-related energy-saving measures can reduce centre running costs significantly.

This Guide is for owners and managers of sports and leisure centres, and shows where and how much energy is used in the provision and treatment of water. It also indicates the areas in

which the most energy is used, and hence the opportunities for the greatest savings.

Leisure centres vary both in size and range of facilities, but each falls within one of three categories:

- swimming pool only
- sports facility with a pool
- sports facility without a pool.

Opportunities for savings exist in all three types of centre. In facilities with a pool, the pool represents most of the water-related energy use, and this is the area to which attention should first be directed. In facilities without a pool, attention should be paid initially to hot water use, as this represents 60% of water-related energy use in this type of centre.

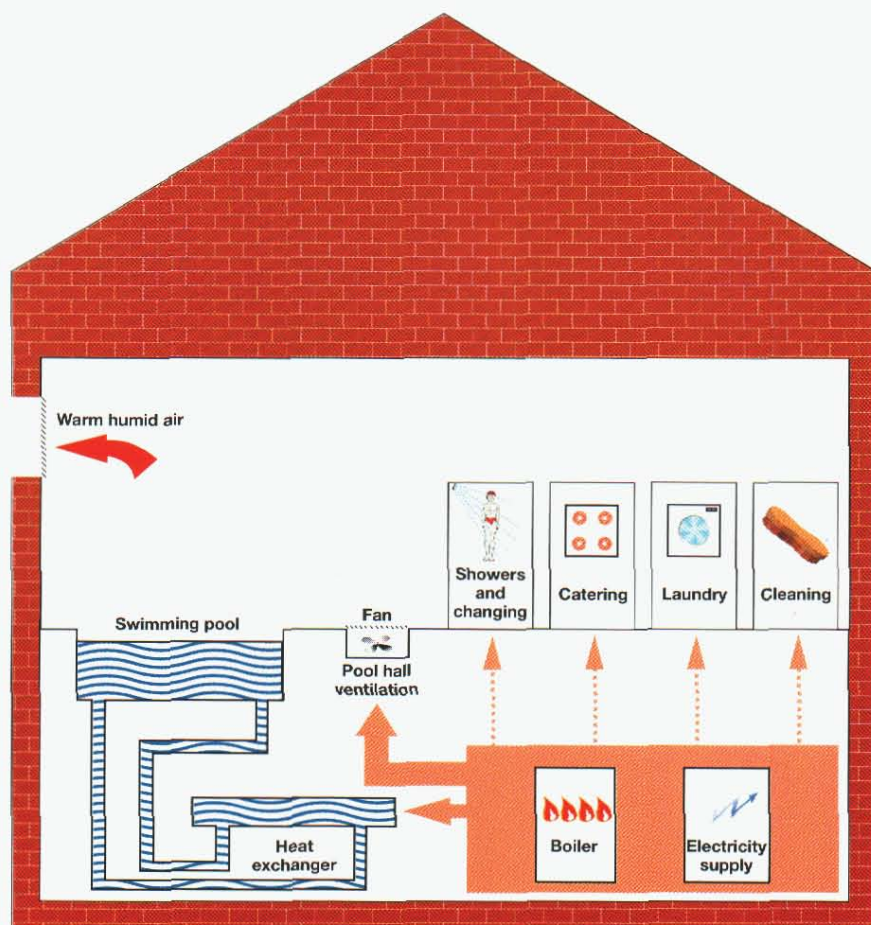
Utility costs

Negotiated utility costs vary from contract to contract, sometimes by as much as 100%. Therefore, typical utility costs used throughout this Guide for calculating energy costs are:

Electricity	Day	5p/kWh
	Night	2p/kWh
Gas		1p/kWh
		(29.3p/therm)




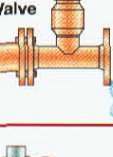

Water (supply and discharge) £1/m³

A flow rate of 1 m³/h is approximately equivalent to the flow from a garden hose. (A kWh of energy is equivalent to the output of a 1 bar electric heater on for one hour.)



Water-related energy use in a centre with a pool

Typical cost of leaks

Two drops/second Annual water and effluent cost	£9.50	
Drops breaking into a stream Annual water and effluent cost	£31	
2 mm stream Annual water and effluent cost	£146	
0.1 litre/minute Annual water and effluent cost	£53	
0-4 litres/minute Annual water and effluent cost	£2100	

2 DOMESTIC WATER

Legionella

(Legionnaires' disease)

Domestic hot water should be stored at 60°C (having previously been heated to >70°C) in order to prevent legionella from flourishing in the hot water supply. Care must be taken to ensure that the temperature at the tap is no higher than 45°C to avoid scalding. Further information is provided in CIBSE TM 13: 'Minimising the Risk of Legionnaires' Disease'

There are four main areas where domestic hot and cold water are used in leisure centres:

- changing areas
- catering facilities
- laundry services
- cleaning.

The efficient delivery of water to the point of use, coupled with the efficient use of water, will result in savings of both energy and water.

Energy is wasted in heating water to a higher temperature than is required. Losses will occur if the cylinder and pipework are poorly insulated. Insulating an unlagged storage cylinder will reduce the rate of heat loss by 70%.

Domestic hot water production

Hot water for showers can be provided by the central boiler plant and a heat exchanger, or by

local hot water heaters. If the central boiler plant provides domestic hot water and there are long pipe runs to the point of use, then local heaters should be considered as an alternative.

For small quantities of hot water, such as for hand basins, the use of wall-mounted electric water heaters should be considered. Where larger quantities of hot water are required, free-standing gas-fired water heaters are more appropriate.

Hot water circulating pumps should be time-controlled to switch off when not required. If they are left running the heat stored in the cylinder will be lost, and energy wasted in running the pump.

All overflow outlets should be located in prominent positions. If they are hidden from view overflow problems can go undetected.

Domestic water saving measures

The number of centre users largely determines how much water is used in toilet and changing areas so, to minimise water consumption, controls should be automated wherever possible. Table 1 shows a number of measures that could help to save water.

There are further opportunities for savings of both water and energy in each of the areas shown in the checklist (opposite).

Did you know?

A small washdown hose can use 1 m³ of water every hour. If this is hidden under a piece of equipment and forgotten for a week (it does happen), then at a combined water and effluent cost of £1/m³ this will cost £24 per day or £168 per week. A trigger-operated spray gun costs about £70; the payback period – allowing £35 for fitting – could be as low as 4½ days.

Measure	Comments	Annual saving	Payback period (years)
Tap restrictors	Valuable for providing equal flow at a number of taps in a wash room	Typically reduces water flow by 15%	1
Push taps	Ideal for public areas where taps may be left running	Based on a tap dripping at 3.5 litres per hour saves 31 m ³ of water per year	1
Shower regulators	Valuable for providing equal flow at a number of outlets	Typically reduces water flow by 20% of water used in showers	1
Push-button showers	Ideal for public areas where showers may be left running	Between 5% and 15% per shower, depending on location	1
Urinal flush controls	Several systems are available	Typical savings of 10% per toilet	<1
Toilet water dams	Adequate flushing needs to be ensured	Typical savings of 20% per toilet	<1

Table 1 Water-saving measures

DOMESTIC WATER

CHECKLIST FOR FURTHER SAVINGS OF WATER AND ENERGY

Opportunity	Reason	Action
Catering facilities		
Are your staff aware of water costs?	Raising staff awareness of water costs will help to promote more efficient use.	Use promotional materials to raise awareness.
Are your staff aware of the importance of preventing water wastage by simple actions such as turning off taps?	Taps that are not properly turned off waste water. Dripping hot water taps also waste energy.	Initiate a good housekeeping campaign to encourage staff to turn off taps. This information will also be valuable to staff who have metered water at home.
Are your staff aware of the importance of using dishwashers efficiently?	Dishwashers used at only part load are extravagant users of both energy and water.	Instigate practices under the good housekeeping campaign to ensure that staff use machines only when there is a full load.
Laundry services		
Are staff aware of the importance of washing at the lowest temperature possible?	The hotter the wash selected the more energy is required for water heating.	Make sure staff are fully aware of the different programmes offered on the machine and that they know which is the most suitable programme for each type of load.
Do staff always load machines fully?	Washing only a part load means that hot and cold water, as well as washing detergent, will be wasted.	Make sure staff are aware that they should wash a full load whenever possible.
Cleaning		
Have you checked whether hot water is used unnecessarily?	Hot water is more expensive to produce than cold water and is sometimes used where cold water would be equally effective, for example, to hose down floors and rinsing.	Check the different ways that hot water is used at your centre and make sure that cold water is used for cleaning processes, unless hot water is essential.
Are all hoses turned off immediately after use?	Hoses left on after use waste a great deal of water.	Fit spring-loaded pistol grips to provide automatic cut-off.



3 HEATING SYSTEMS

Hot water requirements are met either by local water heaters or by a centralised boiler plant, as discussed in chapter 2. To reduce energy costs, this plant should be efficient and well maintained.

Maintenance

The most effective low-cost measure is to ensure that the boiler is operating as efficiently as possible by carrying out regular maintenance on the boiler in line with the manufacturer's recommendations.

Plant room maintenance should also include attention to the circulation and pool water pumps.

Typically, boiler systems require replacement within approximately 25 years. When boilers need replacing, consider the possibility of installing more efficient models, or a combined heat and power (CHP) system. As part of your review, consider whether you need to replace the existing boiler capacity like-for-like; you may, for example, have introduced other energy efficiency measures that have already reduced the energy load on your building.

Types of boiler systems that will improve efficiency are:

- modular boilers
- high-efficiency condensing boilers
- CHP systems.

The potential savings available from installing these systems are shown in table 2. Further information on these systems is available from a number of Good Practice Guides (see back page).

Heating systems	Possible energy saving	Payback period (years)
Modular boilers	up to 15% of heating costs	2-4
High-efficiency condensing boilers	up to 20% of heating costs	2-4
Combined heat and power (CHP)	up to 25% of energy costs	3-5

Table 2 Boiler opportunities

4 POOL EFFICIENCY

Pool water must be heated, chemically treated, filtered, and diluted in order to provide comfortable and hygienic conditions for bathers. Heating pool water is a relatively simple operation. A heat exchanger is generally used to transfer heat from the boiler plant to the pool water.

Chemical treatment in the form of disinfection and filtration is necessary to remove pollution, the main source of which is the bathers themselves. Encouraging bathers to shower before using the pool will reduce contamination. Disinfection and filtration alone, however, will not remove all pollutants, and so the final requirement to maintain a healthy pool is dilution. Dilution reduces the build-up of pollutants from bathers and the by-products of disinfection. Water is lost from a swimming pool through evaporation, filter backwashing and dilution (as shown in figure 1).

Pool water evaporation

Pool water evaporation results in a build-up of humidity and chemicals in the pool hall, and these should be removed to maintain air quality for the bathers and pool staff, and to prevent condensation.

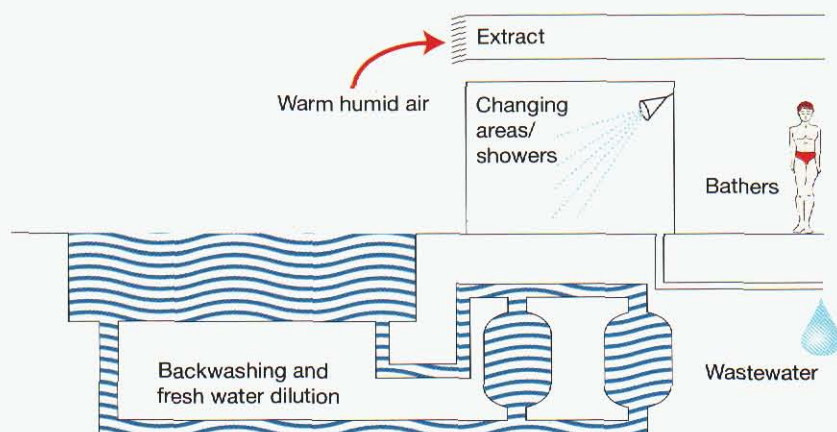


Figure 1 Swimming pool losses

POOL EFFICIENCY

Evaporation leads to high energy costs for two main reasons:

- the pool water must be heated to counteract the cooling effect of the water evaporating from the pool surface
- high ventilation rates, using outside air heated to between 28°C and 30°C, are needed in the pool hall to reduce the humidity.

Predicting evaporation rates and heat loss is complex because the rates are influenced by many factors, such as pool hall air temperature, pool water temperature, pool hall relative humidity and wave features. Figure 2 shows the optimum conditions for bather comfort and for minimum energy use.

A pool cover is the simplest way of reducing evaporation from the pool surface when the pool is not in use, and it can be very cost-effective. With the cover in place, the reduction in evaporation greatly reduces the need for pool heating. In addition, the night-time ventilation rate can be cut dramatically, in line with the reduced condensation risk. Indicative savings for a 25 m x 12.5 m pool are shown in table 3 on page 8. When considering pool covers, remember:

- a pool cover will affect the efficiency of surface water removal systems
- staff must be committed to the regime of using the cover
- the lifespan and capital cost of the cover must be fully assessed in relation to the savings made – curtain covers deteriorate quite quickly.

Other ways of reducing evaporation are listed below.

- The pool hall air temperature should be maintained at 1°C higher than the pool water temperature to minimise evaporation losses and maximise bather comfort. Higher air temperatures will result in greater ventilation losses and discomfort for poolside attendants. A temperature differential greater than 2°C increases ventilation losses by 5-10%.

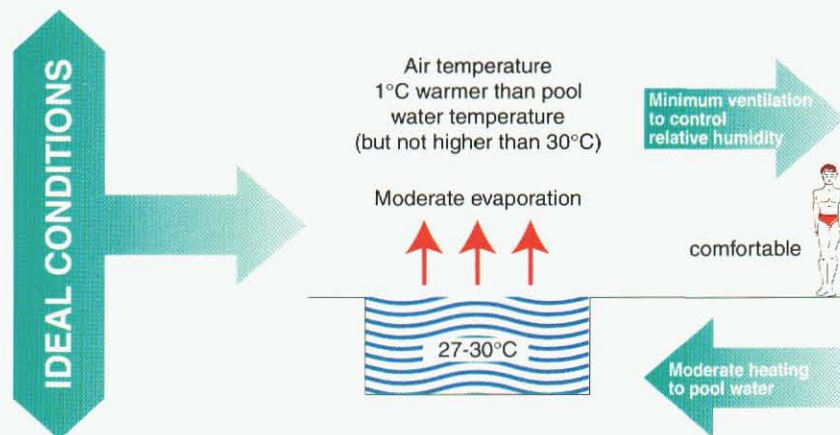
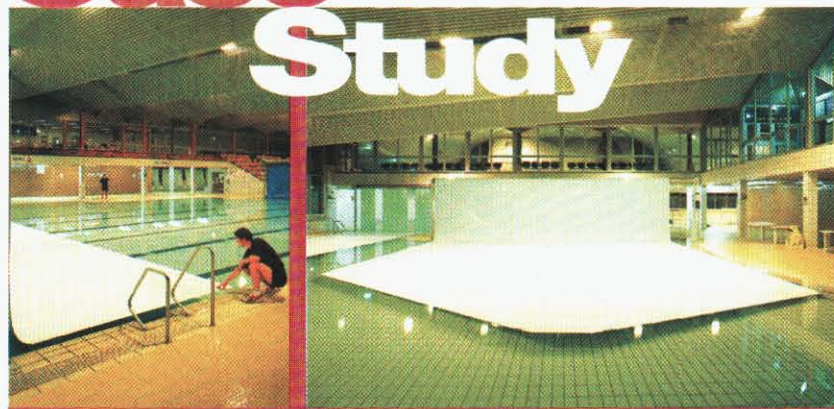


Figure 2 Optimum pool conditions

Case Study



LONDON BOROUGH OF EALING

Ealing runs four pools, ranging from Acton Baths, built of traditional stone and brick in the Edwardian era, to the modern Gurnell Leisure Pool.

Over the past few years automatic pool covers have been installed at each of the pools, the most recent of these being the covers at Gurnell Leisure Centre.

Gurnell Pool has four covers, two for the main pool (separated by means of a hydraulic boom), and two covers for the recreation pool. The savings identified for the Gurnell Pool covers are £6000-£7000 per year. These savings have been maximised by ventilation control when the pool covers are in place. Total savings attributable to all the pool covers installed within the borough are estimated to be in the region of £24 500 per year.

Did you know?

A conventional main pool, 25 m x 12.5 m, with a water temperature of 28°C and an air temperature of 29°C, controlled to a relative humidity of 60%, typically will have evaporative losses each year of 550 m³, equivalent to 305 000 kWh (£3050).

POOL EFFICIENCY

- The pool water temperature should be kept as low as possible, consistent with maintaining comfort for bathers (typically 28°C, but see Good Practice Guide 219, 'Energy efficiency in swimming pools – for centre managers and operators'). Increasing the pool water temperature by 1°C will increase energy costs by 10-15%.
- The drier the pool hall air, the greater the rate of evaporation. If the relative humidity rises above 70-75%, there is a risk of condensation on cold parts of the structure. A relative humidity of 50-70% is generally considered a good balance between reducing evaporation and avoiding surface condensation.
- Wave machines, flumes, etc, agitate the water and so increase evaporation.

In any situation where condensation is a possible concern, regime 3 of table 3 should be adopted (pool cover on overnight with the fans on low speed and the heating on) to ensure a dry hall. It is important that pool covers are used when they have been installed, and that the controls are adjusted to modify the heating/ventilation system as appropriate. By installing a counter, you can monitor the number of times the cover is used.

Heat recovery

Heat can be recovered from the air leaving the pool hall and transferred to the cooler incoming air. Both sensible heat (the heat carried in the air itself) and latent heat (the heat held by the moisture in the air, which is given up when the moisture

condenses) can be recovered. Used in conjunction with ventilation systems, heat recovery can reduce heating energy requirements by up to 30%.

The most common heat recovery systems are run-around coils, cross-flow heat exchangers and thermal wheels. Further information about these systems can be obtained from Good Practice Guide 144, 'Energy efficiency in sports and recreation buildings: technology overview' (see back page for details).

Dehumidification systems

The two most common dehumidification systems are heat pumps and desiccant wheels. Savings from these and other systems are shown in table 4. When using heat recovery systems which include the use of recirculated air, care must be taken to maintain pool hall air quality.

	Energy saving	Payback period (years)
Heat pump or desiccant wheel	Up to 40% of pool hall energy costs	2-6
Run-around coil or cross-flow heat exchanger	Heat transfer effectiveness of up to 75% can be achieved	3-5

Table 4 Heat recovery and dehumidification opportunities

Operating regimes				Annual energy saving		Total annual cost saving	Payback period
	Pool cover	Heating	Ventilation	Electricity kWh (kWh/m ²)	Gas kWh (kWh/m ²)	£ (£/m ²)	Years
1	Off	On	High	No savings	No savings	No savings	N/A
2	Off	On	Low	40 000 (128)	104 000 (333)	2960 (9.47)	Instant
3	On	On	Low	40 000 (128)	265 000 (848)	5190 (16.61)	2.8
4	On	Off	Off	71 000 (227)	479 000 (1533)	9340 (29.89)	1.6
1.39 p/kWh gas; 7.22 p/kWh electricity (day rate), 2.81 p/kWh electricity (night rate)							

Table 3 These overnight energy and cost savings show what can be achieved under different operating regimes for a 25 m x 12.5 m pool. Use the savings per m² to calculate possible savings for other pools. (Source: Good Practice Case Study 76)

POOL WATER TREATMENT

Heat pumps

Heat pumps remove latent heat from moist air, which is dehumidified as a consequence. The incoming colder air is heated by the warmer extracted air and reheated by the heat pump. The process consumes electrical energy (for the heat pump compressor), but up to five times this amount of energy is available for reheating.

If the system is used in combination with a heat recovery system then up to nine times the electrical energy input may be recoverable. When used properly, electric dehumidification systems can save up to 40% of energy costs and typical paybacks of two to six years can be achieved.

Desiccant wheels

A desiccant wheel is a disc-shaped honeycomb matrix, which rotates at speeds of about eight



revolutions per hour. As the wheel turns it absorbs moisture from the pool hall extract air. It then moves out of the extract air stream and into a separate gas-heated stream of air, which evaporates the moisture and discharges it externally into the atmosphere. The dry portion of the wheel re-enters the humid extract air stream where it removes more moisture. Dehumidification is a cost-effective method of extracting water vapour from the pool hall when compared to full fresh air ventilation systems.

5 POOL WATER TREATMENT

Pool water circulation

In order to achieve the required levels of filtration and disinfection, the pool water is continually circulated through the filters and treatment plant. The time taken to circulate the entire contents of the pool through the filter plant is called the turn-over period. The shorter this period the more treatment the pool water is receiving. Inadequate circulation will result in poor water quality when bathing loads are high. Excessive circulation will have an adverse effect on energy consumption. Poor circulation due to pump malfunction, for example, will lead to poor water quality, which may mean additional backwashing is required. To ensure sufficient pool water circulation is obtained, flow meters should be installed to monitor circulation. It is good practice to install three 50% capacity pumps for circulation. This allows pump sizes to be reduced. Care must be taken, however, to maintain the high quality of the pool water.

Filtration

During the circulation of pool water, pressure sand filters remove particulate and biological matter introduced by bathers. To ensure good quality pool water, the filters should operate continuously, with reduced circulation rates overnight and during daytime quiet periods, provided good pool water quality can be maintained. Passing pool water back through the filters to waste is an essential routine in caring for the filters. This process is called backwashing (see box). It is important to ensure that filters are washed either

The cost of backwashing

Example (simplified):

A municipal pool with three sand filters each of area 4.67 m².

The backwash flow velocity sufficient to fluidise the sand bed is 0.5 m/min, equivalent to a volume flow of 2.3 m³/min.

Water required

- Typically 5 minute backwash with a 2 minute rinse = 16.1 m³; for three filters = 48.3 m³
- Water cost at £1/m³ = £48.30
- To heat 1 m³ of mains water to pool water temperature at £0.01 kWh = £0.31
- Heating cost = 48.30 x 0.31 = £14.90
- Cost of backwashing filters = £63.20.

POOL WATER TREATMENT



at a specific pressure differential or at least once a week. This ensures that efficient backwashing is achieved and minimises the backwash period to about 5 minutes, thus reducing the water used. Leaving a longer period between each backwash can result in having to wash for very long periods.

Pool water has typically been heated from 10°C to 27-30°C, depending on pool type, and treated with chemicals. This water is lost as a result of backwashing. Backwashing should therefore be undertaken only when necessary, minimising losses of treated water to maintain good pool water quality. The need to backwash can be determined by monitoring the reduced pressure across the filter as it becomes dirty. However, the length of time between backwashes should be no more than one week.

Filter manufacturers set the minimum length of time required for a backwash. This may clean the

filter adequately, although backwashing should be continued until backwash water is clear. (A viewing window on the filter outlet is the only way to check progress.) A typical backwash period can last from 5 to 10 minutes. After backwashing the normal flow is restarted, but the filter is usually run to waste for a few minutes to allow the filter bed to settle and dirt in the pipework to drain off. Excessive backwash and filter settlement periods are costly in energy consumption.

Fresh water dilution

Fresh water dilution is as important as chemical backwashing to limit the build-up of pollutants from bathers, and disinfection by-products not removed by filtration or disinfection. As well as making bathing more comfortable, proper dilution can help to protect the building fabric by reducing the level of contaminants in the air above the pool. A dilution rate of up to 30 litres per bather per day is recommended.

The dilution requirements (between 10% and 50%) may be met through the addition of fresh water during filter backwashing. Managers should therefore monitor backwashing and water dilution in order to avoid excessive dilution and costs. Typical dilution costs are shown in table 5.

Waste heat and water recovery

Heat can be recovered from the backwashing water by the use of heat exchangers. In addition to recovering heat, the water itself can be reused.

The water from automatic sampling should be returned to the pool water system and not discharged to waste, as this would result in the loss of heated water and chemicals.

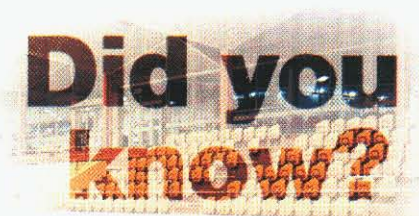
Number of bathers	Dilution requirements	Cost per year (water and heating)
100 per day	3 m ³ per day	£1434
500 per day	15 m ³ per day	£7172
1000 per day	30 m ³ per day	£14 344

Table 5 The cost of dilution

6 LEISURE POOL FEATURES

Many leisure centres now incorporate a number of leisure facilities, such as wave machines, flumes, and saunas. Control of pool features is very important because these have relatively high electricity demands and also increase the evaporation rate from the pool water.

In addition to affecting electricity consumption, these features also determine the maximum electricity demand for the site. To minimise the maximum demand, a schedule of feature usage should be drawn up which restricts the number of different features operating at any one time. Table 6 illustrates various saving measures possible.



Allowing a wave machine to run for an additional five minutes each day increases electricity costs by £80 per year.

Leisure pool facility	Electricity rating	Cost of running for 1 hour each day for a year	Saving opportunities
Wave machines	37-60 kW	£675-£1100	Ensure all staff are aware of operating requirements to minimise the maximum demand* requirements
Fountains, spouts	3 kW	£55	
Water cannons	3 kW	£55	
Rivers, rapids, jets	3 x 22 kW	£1200	
Flumes	5.5-11 kW	£100-£200	
Tyre rides	11-22 kW	£200-£400	
Air blowers	4 kW	£80	Switch off jacuzzi when not in use, and use covers to retain heat
Jacuzzi pump	7.5 kW	£135	
Sauna	6-12 kW	£110-£220	

*Maximum demand is the measured maximum number of units of electricity used in any half-hour period.

Table 6 Energy use of leisure pool facilities

MANAGER'S CHECKLIST

DATE OF INSPECTION

Make a note of your findings and any items requiring attention

Heating systems

- Is a boiler maintenance regime in place? ☐
- Do you have plans to replace any boilers in the near future? ☐
- If you are planning to replace boilers, are energy-efficient replacements being considered? ☐

Pool efficiency

- Do staff know at what temperatures pool hall air and water should be maintained? ☐
- Is a regular monitoring regime in place? ☐
- Do staff know what action to take if temperatures are outside the set parameters? ☐

Heat recovery

- Have you investigated opportunities for heat recovery at your sites? ☐

Pool water treatment

- Is there an effective backwashing regime in place to minimise energy use while ensuring safe pool water conditions? ☐

Leisure pool features

- Is there an effective operating regime for pool water features to minimise energy consumption? ☐

Domestic hot water

- Do you inform staff regularly about practices to minimise water use? ☐
- Have all possible measures been taken to minimise water use? ☐

FURTHER READING

DETR ENERGY EFFICIENCY BEST PRACTICE PROGRAMME DOCUMENTS

The following Best Practice programme publications are available from BRECSU (contact details are given below).

Energy Consumption Guide

- 51 Energy efficiency in sports and recreation buildings: a guide for owners and energy managers

Good Practice Case Studies

- 43 Energy efficiency in sports and recreation buildings: condensing gas boilers
74 Energy efficiency in sports and recreation buildings: potential benefits of boiler replacement
76 Energy efficiency in sports and recreation centres: swimming pool covers. Eastern Leisure Centre, Cardiff City Council

Good Practice Guides

- 129 Good housekeeping in dry sports centres
130 Good housekeeping in swimming pools – a guide for centre managers
137 Energy efficiency in sports and recreation buildings: effective plant maintenance. A guide for sports centre managers and maintenance staff
144 Energy efficiency in sports and recreation buildings: technology overview. A guide for owners and managers
219 Energy efficiency in swimming pools – for centre managers and operators

FURTHER READING

Chartered Institution of Building Services Engineers (CIBSE)

Delta House, 222 Balham High Road, London SW12 9BS
Tel 0181 675 5211
Fax 0181 675 5449

- CIBSE Guide TM13: Minimising the Risk of Legionnaires' Disease

Pool Water Treatment Advisory Group (PWTAG)

Field House, Thrawdeston, Diss, Norfolk IP21 4BU

- Pool water guide:
The treatment and quality of swimming pool water, 1995

Department of the Environment, Transport and the Regions

'Cost-effective water saving devices and practices'; Environmental Technology Best Practice programme. Available from ETSU (see below). For further information contact the Environmental Helpline, telephone 0800 585794.

The Department of the Environment, Transport and the Regions' Energy Efficiency Best Practice programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice programme are shown opposite.

For further information on:

Buildings-related projects contact:
Enquiries Bureau

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Internet **BRECSU** – <http://www.bre.co.uk/breacu/>

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Industrial projects contact:
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Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R&D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Introduction to Energy Efficiency: helps new energy managers understand the use and costs of heating, lighting etc.